Effect of SEEDBED CONDITION on Regeneration of Virginia Pine after Logging

by Edward T. Sucoff

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The Question

WHEN stands of Virginia pine *(Pinus virginiana* Mill.*)* are cut according to usual practices, and no specific action is taken to control subsequent regeneration, the pine often fails to reproduce. A common cause for failure is an unfavorable seedbed condition: logging leaves much of the seedbed undisturbed, and some areas that are disturbed are covered with slash.

Several investigators have demonstrated the inability of Virginia pine to germinate and survive in substantial numbers on undisturbed seedbeds, and have shown further that burning or mechanically disturbing the seedbed greatly increases germination (Stone, 1933; Bramble, 1947; Slocum and Miller, 1953; Sucoff, 1961). However, these experiments

were all conducted beneath mature stands. It has been inferred that similar relationships prevail on logged areas, but this inference has been supported only by general observations. Therefore a study was made on the Beltsville Experimental Forest, near Beltsville, Md., to evaluate the success of pine regeneration for three seedbed conditions commonly found after logging: (1) undisturbed, (2) disturbed in logging, and (3) burned in slash disposal.

The Study

The seedbeds were on four strips that had been clearcut early in the summer of 1953 in a 65-year-old stand that varied from almost pure Virginia pine to mixed pine-hardwood. The cut strips were 3 chains wide; they were alternated with uncut strips 1 chain wide. There was a well developed understory of nearly pure hardwood. The ground cover, generally heavy, varied from grasses and other herbs to dense patches of blueberry. One to two inches of litter and an inch of humus covered the somewhat poorly drained clay-loam soil.

The harvest removed all merchantable trees from the cut strips, and the remaining culls above 4 inches d.b.h. were girdled and poisoned. Logs were skidded tree-length to roadside with a TD-6 tractor and logging cart. It was estimated that this operation exposed mineral soil on 15 to 30 percent of the area. In August 1953 the slash was broadcast-burned; the fire consumed all of the light slash and, on about 60 percent of the area, at least some of the litter. Green brush and compact pine litter did not carry the fire.

During the next 2 years, germination was tested on seedbeds created by the 1953 logging and slash-burning. The four strips were each divided lengthwise into three equal portions for separate sampling to determine whether shade or root competition from the uncut strip would influence germination and seedling survival. On each portion of each strip, three plots were established in November 1953, one each on undisturbed, disturbed, and burned seedbeds. This installation thus totaled 36 plots. In January 1955 a second set of 36 plots was established according to the same distribution, each plot being located within 25 feet of its 1953 counterpart.

Figure 1.--*The undisturbed seedbed. This area was not disturbed by either logging or after-logging fires.*

Undisturbed plots were located on areas where, in November 1953, litter and ground cover looked just as they did before logging (fig. 1); disturbed plots were located where mineral soil had been exposed during the logging (fig. 2); and burned plots were located where the fire had consumed most of the litter and had killed the competing vegetation (fig. 3). The plots were 2 x 3 feet. They were protected from animals and birds by $\frac{1}{2}$-inch mesh hardware cloth.

One hundred Virginia pine seeds were sown on each of the 1953 plots when they were established in November. The number of seeds that fell naturally into the plots was estimated from the catch in nearby seedtraps. Germination was tallied periodically from April through June 1954, the seedlings being pinned so that interim mortality would not interfere with a count of total germination. In October 1954 the living seedlings were counted and the percentage of survival was calculated, based on total germination. Second-year survival was checked the following October; and in September 1956--at the end of the third growing season--heights of the three tallest seedlings on each plot were measured.

Figure 2.--*The disturbed seedbed. Here the mineral soil was exposed by the logging operations.*

Figure 3.--*The burned seedbed. The lighter slash, understory vegetation, and litter were almost completely eliminated here by the after-logging fires.*

One hundred seeds also were sown on each of the second set of plots when established in January 1955, and germination was observed periodically from April through June. As with the 1953 plots, percentage of survival, based on total germination, was determined after one and two growing seasons. Two-year growth of the three tallest seedlings on each plot was measured in September 1956.

The germination and survival data were converted to the arcsin distribution and evaluated by analysis of variance. Differences among treatment means were compared according to Duncan's multiple range test (Duncan 1955).

Results

Neither seedling germination nor survival and growth were significantly affected by plot positions within the logged strips. Therefore plot positions are combined in presenting the data, and results are discussed only in relation to seedbed conditions.

Germination was significantly better in both sowings on the disturbed and the burned seedbeds than on the undisturbed ones (table 1). However, germination was significantly higher on disturbed seedbeds than on burned seedbeds in the first sowing, and significantly higher on burned than

Table 1.--*Germination and seedling survival of Virginia pine, by seedbed condition*

Date of sowing	Seedbed condition	Germination	Survival of germinated seedlings after--	
			1 growing season	2 growing seasons
		Percent	*Percent*	*Percent*
November 1953	Undisturbed	10 a*	59 a	55 a
	Disturbed	40 c	68 a	64 a
	Burned	24 b	76 a	65 a
January 1955	Undisturbed	16 a	43 a	39 a
	Disturbed	35 b	76 b	68 b
	Burned	53 c	83 b	65 b

*Within each sowing date in each column, means followed by the same letter do not differ significantly, and those followed by different letters do differ significantly from each other at the 5-percent level. Each figure is a mean for 12 plots.

on disturbed ones in the second. The cause of this inconsistency between sowings is uncertain. Possibly unfavorable conditions associated with blackened soil or with ashes were present on the burned seedbeds at the time of the first sowing, but had dissipated by the time of the second sowing.

Survivals after two growing seasons, in percentage of total germination, also were higher in both sowings on the two altered seedbeds than on the undisturbed ones, but the

differences were statistically significant only for the second sowing (table 1). In numbers, mean survivals per plot for both sowings combined were about 4 times as many on the altered seedbeds as on the undisturbed ones, as shown below:

Seedbed Condition	*Seedlings per plot after 2 years (number)*
Undisturbed	6
Disturbed	25
Burned	25

Growth, as well as germination and survival, was affected by seedbed conditions (table 2). Seedlings grew tallest on burned seedbeds and least where seedbeds had not been disturbed.

Table 2.--*Mean heights of seedlings, by seedbed condition and sowing date, based upon the three tallest seedlings on each plot*

Seedbed condition	Height in 1956	
	Seed sown in November 1953	Seed sown in January 1955
	Inches	*Inches*
Undisturbed	23 a	6 a*
Disturbed	28 b	9 ab
Burned	35 c	12 b

*Significance of differences within columns is designated as in table 1; where a 2-letter designation appears, means followed by any letters in common do not differ significantly from each other. Each figure is a mean for 12 plots.

Seedbed conditions affected the subsequent development of competing vegetation: 2 years after logging, the burned plots still supported only grasses and a few annuals; the disturbed plots, in contrast, looked much like the undisturbed ones. Both of the latter had many herbs, many woody shrubs, and numerous seedlings and seedling sprouts of oak and maple.

Discussion

The study results confirmed the common general observation that both the mechanical disturbance of seedbeds that occurs during logging, and slash burning after logging, favor the establishment of Virginia pine regeneration. The results also agree with findings in comparable experiments with loblolly pine (Wenger and Trousdell, 1958).

Of the two means for altering the seedbed conditions --fire and mechanical disturbance--fire is the more effective in several respects. (1) It removes slash, which not only is a fire hazard but also tends to exclude pine regeneration. (2) Fire kills many of the established shrubs and undesirable hardwood species; this prolongs the period in which mineral-soil seedbeds are available and competition is reduced. It also reduces the hardwood component of the next stand. (3) Fire increases the early growth rate of the pines, possibly by releasing the nutrients in the consumed litter, slash, and vegetation.

Fire tends to be followed for several years by herbaceous plant covers composed largely of grasses. This could have adverse effects if it led to excessive build-ups of rodent populations, since Virginia pine is known to be susceptible to girdling damage by mice during the seedling and small-sapling stages (Church, 1954). These relationships of seedbed treatment, plant cover, and rodents were not examined in the present study; they are mentioned in recognition of the possibility that fire can lead indirectly to rodent damage.

The results in this study--about 4 times as many pine seedlings present after 2 years on burned or disturbed plots as on undisturbed ones--suggest the practicability of area-wide treatments to obtain full stocking of Virginia pine after logging.

Treatment, of course, presumes a seed source, and absence or inadequacy of advance reproduction. Either a broadcast burn or overall scarification with suitable machinery, such as a heavy disk, is a possible treatment. Since fire consumes logging slash, and generally reduces small hardwood competition to a greater degree than scarification does, it would seem in most places to be the preferable treatment. However, scarification would be an effective alternative

where burning is not feasible. Particularly when timed to take advantage of good pine seed crops, either treatment--barring interference by wildlife--should result in satisfactory pine regeneration.

Summary

The effect of three seedbed conditions on Virginia pine regeneration was studied. The seedbeds were those commonly found after logging--undisturbed, disturbed by logging, burned in slash disposal. Four times as many seedlings were present after 2 years on the burned and disturbed seedbeds as on the undisturbed ones. The differences in numbers stemmed from differences in both germination and survival. Growth of the seedlings was most rapid on burned seedbeds and slowest on undisturbed ones. It is suggested that either broadcast burning or overall mechanical scarification would be practicable treatments to apply for the purpose of regenerating fully stocked stands of Virginia pine after logging.

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